The effect of aureomycin upon lamb mortality and body weights and the effect of delayed feeding upon weaning weights
by James W Bassett

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Animal Industry at Montana State College
Montana State University

Abstract:
Aureomycin was fed to mature ewes to determine its effect on birth weights and lamb mortality. A total of one-hundred nine ewes received a daily supplement containing 50 milligrams of Aureomycin starting one month before lambing. An equal number of ewes received the same supplement without the Aureomycin. Birth weights of the single lambs averaged 10.7 pounds for both the control group and the group receiving Aureomycin. Average birth weight for twins was 9.3 pounds for the controls and 9.5 pounds for the Aureomycin group. One set of triplets in the control group averaged 9.5 pounds. Death losses within the first week after birth were three singles and seven twins for the control group and two singles and two twins for the Aureomycin group. Causes of death were determined by autopsy and showed no great difference among groups.

Assay of colostrum and milk samples showed an Aureomycin content when the ewe was being fed an Aureomycin supplement.

One group of mature ewes with single lambs received Aureomycin at a level of 50 milligrams per day for a period averaging 20 days after lambing. Another group received the same supplement without Aureomycin for the same period of time. A third group received no supplement the first ten days of the period and then received the control ration. Weights of the lambs were recorded at the end of the supplemental feed period. Another weight was taken at 74 days and the weaning weight at approximately 132 days of age. There was no significant difference in lamb gains at the end of the supplemental feed period. The control lambs showed significantly ($P<.05$) greater gains at both 70 days and weaning than either the Aureeomycin or delayed feed groups. The control lambs gained 78.0 pounds from birth to weaning while the Aureomycin and delayed feed groups gained 71.2 and 71.8 pounds, respectively.

Two-year-old ewes with single lambs were fed pelleted supplements at a level of one pound per day and the Aureomycin content for one group was 100 milligrams per day. The Aureomycin supplemented group gained 65.4 pounds from birth to weaning, and the controls and delayed feed groups gained 60.0 and 63.1 pounds, respectively. These differences were not significant.

Twin lambs from the control group gained 58.4 pounds from birth to weaning as compared to 54.2 pounds for the twin lambs where the ewes received 100 milligrams of Aureomycin per day. There was no significant difference in gains at any weigh period.

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ABSTRACT

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One group of mature ewes with single lambs received Aureomycin at a level of 50 milligrams per day for a period averaging 20 days after lambing. Another group received the same supplement without Aureomycin for the same period of time. A third group received no supplement the first ten days of the period and then received the control ration. Weights of the lambs were recorded at the end of the supplemental feed period. Another weight was taken at 74 days and the weaning weight at approximately 132 days of age. There was no significant difference in lamb gains at the end of the supplemental feed period. The control lambs showed significantly ($P < .05$) greater gains at both 70 days and weaning than either the Aureomycin or delayed feed groups. The control lambs gained 78.0 pounds from birth to weaning while the Aureomycin and delayed feed groups gained 71.2 and 71.8 pounds, respectively.

Two-year-old ewes with single lambs were fed pelleted supplements at a level of one pound per day and the Aureomycin content for one group was 100 milligrams per day. The Aureomycin supplemented group gained 65.4 pounds from birth to weaning, and the controls and delayed feed groups gained 60.0 and 63.1 pounds, respectively. These differences were not significant.

Twin lambs from the control group gained 58.4 pounds from birth to weaning as compared to 54.2 pounds for the twin lambs where the ewes received 100 milligrams of Aureomycin per day. There was no significant difference in gains at any weigh period.

INTRODUCTION

Sheep producers are vitally interested in breeding programs and selection methods which will increase the production of lamb and wool. Nutrition is important in increasing the effectiveness of genetic improvement. Gains now being made through the application of nutritional and genetic research can be further increased by decreasing the death loss of young lambs.

The major death loss in lambs occurs within the first week after birth, and pneumonia is one of the main causes. Antibiotics have been found to control pneumonia to a large extend in the case of human medicine, and they have also been successfully used in the field of veterinary medicine. Known remedies are of little value unless they can be effectively and economically applied, and where large numbers of ewes are being lambed it is often difficult or impossible to give much attention to individual lambs. One objective of this experiment was to determine if it would be possible to decrease lamb death losses by feeeding Aureomycin to the ewes.

Antibiotics are included in many livestock rations. Beneficial results have been obtained with nonruminants and to a lesser and more variable degree with ruminants. Advantages found from feeding antibiotics include faster and more economical gains, fewer digestive disorders, and reduced death loss in some cases. The greatest advantage with ruminants appears to be with young animals where the nutritional requirements are similar to the requirements of monogastric animals. Antibiotics have been given to young ruminants by injection, drench, capsule or added to their feed. A second objective of this experiment was to determine if it was possible to provide Aureomycin to the lamb through the milk of the ewe. Lamb gains to weaning are used as a measure of the effectiveness of this method of feeding Aureomycin.

Lambs are dependent upon the milk of the ewe for the major part of their early growth. A peak of milk production is reached in dairy cows shortly after the start of lactation. If this peak production is not taken, the cow "dries back" to the level being taken, and the maximum potential production is not realized. The peak of milk production for sheep under a similar lactation curve may be reached at a time when the lamb is still too small to take the full potential. A ewe with twin lambs, however, might not have adequate production for the demand at any period. The third objective of this experiment dealt with the delayed feeding of ewes with single lambs to determine the possibility of increasing total milk production by delaying the peak of milk production.

REVIEW OF LITERATURE

Aureomycin is the name commonly used for the antibiotic, chlortetracycline. The manufacturing process for chlortetracycline is patented by the Lederle Laboratories, and the product is sold under the trade name of Aureomycin, or Aurofac in the case of supplements for livestock feeds.

Discovery of benefits from Aureomycin in livestock rations

The discovery of growth promoting factors in antibiotics was made by Stokstad *et al* (1949) as they investigated *Streptomyces Aureofaciens* as a source of vitamin B_{12}. The addition of crude preparations of *S. aureofaciens* culture material gave a growth response in chicks even when vitamin B_{12} was present in adequate amounts in the basal diet. The response was later shown to be due to the presence of surprisingly small amounts of Aureomycin, and other antibiotics which were active.

Stokstad and Jukes (1950) fed chicks a diet containing adequate levels of vitamin B_{12} and added small amounts of Aureomycin. The feed containing Aureomycin gave a significant extra growth response.

Jukes *et al* (1950) added Aureomycin to pig rations containing adequate vitamin B_{12}. The addition of 100 milligrams of Aureomycin per kilogram (2.2 pounds) of basal ration increased average daily gains from 0.62 to 0.86 pound. The same amount of Aureomycin without the vitamin B_{12} gave average daily gains of 0.87 pound. A second experiment with Aureomycin levels of 50 milligrams and 200 milligrams per kilogram of basal ration gave increases from 0.84 pound to 1.22 and 1.51 pounds, respectively.

Aureomycin transfer into colostrum or milk

The feeding of Aureomycin to mature animals has been limited. The discovery of benefits from feeding Aureomycin was with growth rate in young animals, and the bulk of the investigations have been with growing and fattening rations.

Carpenter (1951) fed sows a diet containing 0.5 percent of an A.P.F. supplement containing Aureomycin. Pigs from these sows showed no greater gains than those whose dams were fed the basal ration. The author concluded that there was no antibiotic transferred to the pigs through the milk.

In two experiments with swine, Beeson et al (1953, 1954) fed rations supplemented with Aureomycin from pregestation to one week after farrowing. The authors concluded that 20 to 45 grams of Aureomycin per ton increased birthweights of pigs 0.09 to 0.31 pounds; but it did not increase the number of pigs farrowed per litter, the liveability of pigs, the percent of pigs weaned or the weaning weight of pigs.

Maddock et al (1953) determined that sows require approximately 1.5 milligrams of Aureomycin per pound of body weight to obtain consistent detectable levels of the antibiotic in the milk. This level of Aureomycin would correspond to 80 to 100 grams of chlortetracycline per ton of ration, depending on the feeding rate.

Lasley et al (1954) in summarizing antibiotic trials with swine rations (48 total) stated there seemed to be little or no advantage in birth weights or weaning weights from feeding antibiotics to brood sows during gestation. There was no evidence to indicate there was an accumulation of antibiotics in the colostrum as measured by liveability of newborn pigs.

Hag et al (1952) fed lactating dairy cows 130 milligrams of Aureomycin daily. The results showed no effect on the bacterial flora of the milk. Either the Aureomycin was not going into the milk or, if present, was of such a low concentration as not to interfere with curd formation.

Martin et al (1955) fed Aureomycin to dairy cows in the form of Aurofac 2A at a rate equivalent to 390 milligrams per cow daily. Samples of milk were taken from cows receiving Aureomycin and from cows previously fed Aureomycin. These milk samples were assayed for Aureomycin content and no detectable amount was found in any of the samples.

Lassiter (1955) reviewed 130 articles concerned with the feeding of antibiotics to dairy cattle and reported no Aureomycin in the milk of cows fed 700 milligrams daily for 10 days. In the several studies relating to mature animals, Aureomycin apparently had no pronounced effect on the appetites or the wellbeing of the animals.

The effect of Aureomycin on death losses and general health

The reports mentioned previously, Lasley et al (1954) and Beeson (1953, 1954), indicated that feeding antibiotics to the brood sow had no apparent effect on liveability of newborn pigs.

The Journal of the American Veterinary Medical Association (1955) reported Aureomycin was used to treat pneumonia in young pigs. Typical symptoms of pneumonia appeared at the age of 20 days and half the pigs were immediately started on Aureomycin at the rate of 40 milligrams per kilogram of body weight. Aureomycin was fed to some pigs for 10 days and to the remaining treated pigs for 50 days. The control group weighed 17 kilograms (37.4 pounds) at 80 days of age while those treated with Aureomycin for 10 days and 50 days weighed 27 kilograms (59.4 pounds) and

32 kilograms (70.4 pounds), respectively.

A study with weaned pigs by Becker et al (1952) illustrated the use of Aureomycin in preventing and treating a disease condition where diarrhea was the clinical symptom. Feeding 10 grams of Aureomycin per ton of feed prevented the disease condition from developing in the treated group. The control lot was divided into two groups about five weeks after the start of the experiment when it seemed that some of the pigs would not survive. One group was fed 10 grams of Aureomycin per ton of ration, and the other group was continued as a control. The pigs fed Aureomycin gained 1.65 pounds per day and required 288 pounds of feed per 100 pounds of gain, while the control pigs gained 0.55 pound per day and ate 475 pounds of feed per 100 pounds of gain. A postmortem examination of the five pigs remaining on the control ration showed that four of the animals had pneumonia involving 15 to 30 percent of the lung tissue.

A summary of swine feeding trials in which enteritis was mentioned was compiled by Maddock and Brackett (1956). The animals used in all of the experiments appeared to be normal and healthy at the start of the trials and, with one exception, the enteritis outbreaks occurred naturally. Aureomycin either prevented or lessened the incidence and severity of scouring as compared to control lots not receiving the antibiotic.

Lassiter (1955) reviewed a total of 130 papers on the feeding of Aureomycin in the rations of dairy cattle. He concluded that the inclusion of Aureomycin in the rations of dairy calves seems to be best justified by the beneficial effect in reducing calf scours and thus calf mortality.

Jordan (1951) reported that feeder lambs showed a reduction in death loss from enterotoxemia in Aureomycin supplemented lots. This reduction of death losses from enterotoxemia was also brought out by Kunkel et al (1956) in reporting death losses over a three year period of feeding Aureomycin. Their report showed a death loss of 4.3 percent from enterotoxemia and a toal death loss of 5.2 percent in 230 control lambs. The 353 lambs receiving Aureomycin supplements had no death loss due to enterotoxemia and only 1.7 percent deaths from all causes.

Kunkel et al (1956) indicated that chlortetracycline apparently reduced the incidence of digestive disorders, diarrhea accompanying self-feeding and enterotoxemia. This reduction was thought to result from a "transitory diminution of food consumption during the first two weeks of the feeding trial."

Johnson et al (1956) found that supplementation with Aureomycin under commercial feed-lot conditions was highly effective in the control of enterotoxemia. No deaths occurred in the four pens receiving Aureomycin and deaths did occur in the other pens.

Hatfield et al (1954) creep fed wether lambs and lost one lamb from enterotoxemia in the control group and two in the Aureomycin group.

Perry et al (1954) administered 24 milligrams of Aureomycin per day by capsule to beef calves. Scouring seldom occurred in the Aureomycin lot but was a definite problem in the control lot. Aureomycin cured scouring when administered to control animals. The amount required varied from 12 milligrams to 231 milligrams total over a period of one to three days.

MacKay et al (1952) fed a supplement containing Aureomycin and vitamin B_{12} and found no evidence of scours in either the control or supplemented calves.

Loosli et al (1951) noted a greater incidence and severity of scours in control calves as compared to those supplemented with Aureomycin.

Lassiter et al (1955) fed Aureomycin to dairy calves at a level of 75 milligrams per day. A lower incidence of scours was observed in the Aureomycin supplemented calves than in the control calves.

Gaunya et al (1955) raised dairy calves on a limited whole milk system and calf starter. The starters were supplemented with 0, 2.5 and 5.0 pounds of Aurofac 2A per ton. There was no significant incidence of scours among groups.

The effect of Aureomycin on weight gains and feed efficiency

Considerable research has been conducted using Aureomycin for growing and fattening animals. Increased gains for young dairy calves supplemented with Aureomycin are reported by Loosli et al (1951), MacKay et al (1952), Murley et al (1952), Rusoff et al (1953) (1954), Lassiter et al (1955), Pritchard et al (1955), MacFadden and Richards (1956) and Landagora et al (1957). An improvement in feed efficiency was also noted in many cases.

There was neither increased weight gains nor improved feed efficiency for Aureomycin supplemented dairy calves in the work reported by Bloom and Knodt (1953) and by Gaunya et al (1955).

Lassiter (1955) reviewed the literature pertaining to Aureomycin and stated that an advantage of 10 to 30 percent in growth rate during the first 16 weeks was shown by Aureomycin supplemented dairy calves. Most of the growth advantage occurred during the first 8 weeks. Any growth advantage afforded by the Aureomycin during the early life of the calf became insignificant in the mature animal.

Perry et al (1954) supplemented beef calves at a level of 24 milligrams of Aureomycin per hundred pounds of liveweight and found an increase in the average daily gains of 1.78 pounds as compared to the control lot at 1.59 pounds. The gains were not statistically significant.

Early work by Colby et al (1950) with fattening lambs indicated an adverse effect from Aureomycin supplementation. A basal ration gave gains of 0.52 pound per day, while the administration of 100 milligrams of Aureomycin by capsule daily caused the lambs to go off feed and lose 0.16 pound daily. A third lot fed the basal ration plus all known B-vitamins and 100 milligrams of Aureomycin lost 0.20 pound per day.

Later work with lower levels of Aureomycin showed conflicting results. Hatfield et al (1954) found an average advantage of 0.055 ± 0.014 pound in daily gains for Aureomycin supplemented lambs in three trials. Improved feed efficiency was also reported. Johnson et al(1956) reported lambs under commercial feed-lot conditions receiving 10 milligrams of Aureomycin per pound of feed had average daily gains significantly greater than the controls or other treatment groups. Botkin and Paules (1954) reported feeder lambs receiving 10 milligrams of Aureomycin per pound of feed showed some advantage in rate and efficiency of gain. These advantages were not statistically significant.

Improved feed efficiency of Aureomycin supplemented lambs was reported by Kunkel et al (1956), although there was no significant difference in gains. Bohman et al (1955) reported no difference in rate of gain for orphan wether lambs receiving Aureomycin as compared to controls.

A lamb fattening trial conducted by Thomas et al (1956) showed little or no advantage in daily gains or feed efficiency for lambs receiving Aureomycin as compared to the other rations being fed. Lambs fed Aureomycin dressed out the highest, but their carcass grades were not as high as some of the lots. No digestive disturbances were noted, and no lambs were lost during the trial.

The response of suckling lambs receiving Aureomycin is varied. Beeson et al (1954) implanted antibiotics in two-day-old lambs and obtained no significant effect on growth rate. Implantation of 140 milligrams of Aureomycin in 44-day-old lambs gave no effect on growth rate. Jordan and Bell (1954) gave Aureomycin by drench, implantation and by creep feeding, and the Aureomycin gave 12 to 17 percent faster gains, but these gains were not significantly different than the controls. Implantanting 80 milligrams of Aureomycin in day-old or week-old lambs gave greater daily gains to the Aureomycin fed lambs once and to the control lambs twice. All differences were small and not significant.

Kinsman and Riddell (1952) used antibiotics in creep rations of suckling lambs and found no appreciable difference in rate of gain or feed efficiency. Luce et al (1953) fed Aureomycin in the creep ration at a level of 10 milligrams per pound of feed. Supplementation for 14 to 21 days after birth gave no increase over the control group. Supplementation from one or three weeks old until weaning gave lighter weights. Daley (1956) found that Aureomycin in the creep ration increased rate of gain during the first two weeks. Feed efficiency for the trial period was improved by Aureomycin, but rate of gain for the trial period of 50 days was not increased. Madsen et al (1955) reported no measurable effect upon growth rate or feed consumption when the creep feed was supplemented at a level of 10 milligrams per pound of feed.

Milk production

Research on milk production has been largely confined to dairy cows where the calves are taken from the cow after birth and accurate measurements of production can be obtained.

The peak of milk production in dairy cows does not extend for more than 10 weeks from the date of calving, according to Mahadevan (1951). Thereafter, there is a decline in production which may be rapid in some cows and slow in others. The best methods for improving persistency of lactation lie in the direction of better feeding and management.

Gooch (1935) indicated that more persistent milkers tend to start their lactation period with relatively low production.

Sanders (1930) reported that maximum daily yield may be largely determined by the area of the mammary gland, while persistency seems to be chiefly a nutritional factor. Good conditions of management raise both maximum daily yield and persistency of production. The total production for the lactation period is increased in greater proportion than the maximum daily yield.

Larson et al (1956) reported a normal attainment of maximum daily production of milk and fat after about the first month in dairy cows.

Flux and Patchell (1954) fed monozygous twin cows at normal and low-plane levels of nutrition during lactation. The milk production of the normal-plane cows was significantly ($P < .01$) greater for the experimental period, from the third to eighth weeks inclusive, after calving. The normal-plane group produced more milk for the whole lactation period than the low-plane group, but the difference was not statistically significant.

Burris and Baugus (1955) reported on milk production in ewes and stated that milk production was highest during the first four weeks, declined rapidly the next four weeks and declined less rapidly during the remaining time until weaning. The total milk production and growth of the lamb to 16 weeks were highly correlated.

Barnicoat et al (1949) of New Zealand gave the peak of lactation for ewes at 20 to 30 days after lambing. The peak of production was reached earlier in low producers within age groups. Some of the 6-year-old ewes would have produced more milk than recorded had the lambs been able to consume more of the milk during early stages of lactation. This loss of early production was true also for 2-year-old ewes, but to a lesser degree. The average yield over 12 weeks lactation was not raised more than 5 percent when the extra milk was taken into account. As the excess production occurred at the early stage of lactation when milk secretory activity was at its height, any drying-off effect may have been offset as the lamb's ingestion capacity increased. Results indicated that nutrition during pregnancy was important for maintaining yield during the latter part of lactation. Feeding during lactation was the primary factor influencing both initial and total milk yield. A maximum milk yield was obtained by liberal feeding during late pregnancy and throughout lactation. Under "fat lamb" farming conditions, large differences in milk in-take were compensated at later stages by the effect of grass feeding. Milk nutrients were of major importance throughout the entire 12 weeks under conditions simulating "hard hill-country" conditions.

Coop (1950) reported that the level of nutrition during pregnancy had little if any influence on the rate of growth and weaning weights of lambs. Differences in weaning weights of the lambs were accounted for almost entirely by the level of nutrition after lambing.

Work reported by Van Horn et al (1956) indicated that feed differences before lambing caused a difference in weaning weights. Groups fed the highest levels before lambing weaned an average of 79.2 pounds while the lowest fed groups weaned an average of 74.4 pounds. Intermediate groups between the highest and lowest weaned 74.9 and 77.5 pounds depending on the feed level.

Wallace (1948) reported that nutrition during the last 6 weeks of pregnancy influenced both the birth weight of the lamb and the potential milk yield of the ewe. Lighter lambs were unable to take full advantage of the milk yield of the ewe. The capacity of the lamb in the early stages of lactation helps to govern the actual yield of the milk produced. The peak of milk production was reached from the second to the fourth week of lactation and then tapered off rapidly.

EXPERIMENTAL PROCEDURE

Location of experiment

Supplemental feeding and lambing were conducted at the Ft. Ellis farm of the Montana Agricultural Experiment Station located four miles east of Bozeman, Montana. The sheep were brought to the farm a month before the start of lambing and were weighed and branded for the prelambing feed treatments. The ewes were kept at the Ft. Ellis farm until approximately one month after the start of lambing. The ewes and lambs then were added to the range band from which the ewes originated. The band was on range land at a White Sulphur Springs ranch located about 100 miles north and east of Bozeman until late summer when the lambs were weighed and weaned at the conclusion of the experiment.

Experimental sheep

The experimental sheep were taken from a range band belonging to the Animal Industry and Range Management Department, Montana Agricultural Experiment Station. This band is known as the "purebred band" and is used for research in sheep breeding. This band has also been used for nutritional studies when it has been felt that such studies would not jeopardize or influence the breeding studies involved.

Facilities available were not adequate to permit the inclusion of the entire band in this experiment. The band consists of Rambouillet, Targhee and Columbia ewes. The breeding study does not involve between-breed comparisons, so it was felt that the effect of taking ewes out of the band could be minimized by taking all of one breed. All of the Targhee ewes, totaling one-hundred eighty eight, were taken from the band and moved to the Ft. Ellis farm. There were thirty Rambouillet ewes included in the experiment in addition to the Targhee ewes. These Rambouillet ewes had been bred to Targhee rams in the fall, and the lambs were to be eartagged for retention in the Targhee breed lines.

The ewes ranged in age from two to seven years old with an age distribution as shown in Table I.

Table I. Age distribution of ewes

Age	Number
2	47
3	73
4	37
5	26
6	21
7	14
Total	218

Prelambing treatment

The ewes were divided into two lots by age groups within breed lines, so that differences which might occur because of these two factors would be equalized. The distribution by age and breed line is shown in Table II.

The ewes were weighed and branded according to the treatment they were to receive. The brand was placed on the right shoulder with different colors for easy identification. The ewes were separated into their respective lots each morning by running them through a cutting chute and were then fed a pelleted supplement. After sufficient time had lapsed for the supplement to be eaten, the ewes were combined into one group until the following morning. Hay was fed to the combined group in the afternoon.

The prelambing feeding began one month before the start of lambing

Table II. Distribution of ewes by age and breedline

Breedline		20		22		24		26		28		28-		
Age	Lot	1	2	1	2	1	2	1	2	1	2	1	2	Total
2	1	4		5		3		7		5		3		27
	2		4		6		2		8		8		4	29
3	1	7		7		2		8		9		4		37
	2		6		7		1		8		9		6	37
4	1	2		3		2		3		4		3		17
	2		2		2		3		3		4		1	15
5	1	2		0		1		3		4		3		13
	2		3		1		0		3		4		3	14
6	1	3		1		0		3		1		0		8
	2		2		0		0		3		1		1	7
7	1	2		1		0		3		1		0		7
	2		1		1		1		2		1		1	7
Total		20	18	17	17	8	7	27	27	24	24	13	16	218

and was continued for all ewes until they lambed. The ewes which had not lambed by May 1 were returned to the main band at White Sulphur Springs.

Prelambing rations

The ewes were divided into lots to permit the feeding of two different pelleted rations. The basic, or control, ration will be referred to as Ration 1. Ration 2 was the same composition as Ration 1 with Aureomycin (chlortetracycline HCl) added in the form of Aurofac 10 at a level of 100 milligrams of chlortetracycline per pound of feed. Both rations were fed at a level of one-half pound per head per day. Average quality alfalfa hay was fed at a rate of approximately five pounds per head per day. There was no grazing available at any time during this period. Composition of the supplemental pellets is shown in Table III.

Table III. Composition of pelleted rations

Ration number		1	2
Ingredients		Percent of ration	
Barley		27.5	26.5
Wheat mixed feed		25.0	25.0
Soybean oil meal		20.0	20.0
Linseed oil meal		5.0	5.0
Alfalfa, dehydrated		15.0	15.0
Molasses		7.5	7.5
Aurofac 10 1/		0.0	1.0
	Total	100.0	100.0

1/ Contains 10 grams of Aureomycin per pound. When added at a 1 percent level to the ration, the Aureomycin content was 100 milligrams per pound.

Postlambing treatment

As each ewe lambed, the ewe and lamb or lambs were brought into the lambing shed. The lambs were weighed, eartagged and a record made of the following items: lamb number, ewe number, date of birth, sex, strength score and the prelambing feed treatment of the ewe. Each lamb was vaccinated for enterotoxemia at eight to ten days of age.

The ewes were assigned to a postlambing feed treatment on the basis of their age, whether or not they had a single or multiple birth and their prelambing feed treatment.

Two-year-old ewes were kept separate and given a higher level of feed than the mature ewes. The seven-year-old ewes were evenly distributed into the feed treatments. Other age groups were assigned to postlambing lots without regard to age.

Twins were kept separate from single births. Two-year-old ewes with twins had one lamb removed. Removing one lamb would help to minimize the drain on the two-year-old ewe which had not made her full growth and increase the survival and growth possibilities for the lamb.

Approximately equal numbers of ewes from both prelambing feed treatments were lotted into each of the postlambing lots.

Lamb weights were recorded shortly after birth and once a week thereafter until May 9. The ewes and lambs were then trucked to White Sulphur Springs. Lamb weights were recorded again on July 2 and August 29, when the lambs were weaned.

Postlambing rations

The same rations used before lambing were continued for the postlambing feed treatments. Only two feed treatments were used before lambing, but by using different amounts and times of feeding, there were eight postlambing treatments.

The mature ewes with single lambs were divided into three lots and were given a pelleted ration at the following levels and times:

Lot 1--1/2 pound Ration 1 per head per day after leaving the jug

Lot 2--1/2 pound Ration 2 per head per day after leaving the jug

Lot 3--1/2 pound Ration 1 per head per day ten days after leaving the jug

The two-year-old ewes were fed at a higher level because of their lack of maturity. The lot numbers and treatments for two-year-old ewes were as follows:

Lot 4--1 pound Ration 1 per head per day after leaving the jug

Lot 5--1 pound Ration 2 per head per day after leaving the jug

Lot 6--1 pound Ration 1 per head per day ten days after leaving the jug

Mature ewes with twin lambs were fed a higher level than mature ewes with single lambs. Only two treatments were used with the twin lambs, as all ewes received pellets as soon as they left the jug.

Lot 7--1 pound Ration 1 per head per day after leaving the jug

Lot 8--1 pound Ration 2 per head per day after leaving the jug

All lots received average quality alfalfa hay at a rate of approximately five pounds per head per day. Supplemental feeding of pellets was discontinued May 9 for all lots.

<u>Colostrum and milk samples</u>

Samples of colostrum and milk were taken for an assay determination of chlortetracycline HCl. Only ewes with single lambs were used for this portion of the experiment, as it was felt that a ewe with twins would need all the milk she could produce.

A sample of colostrum was hand-milked from one side of the udder within two hours after birth of the lamb. Samples were taken from ewes of all ages and from both prelambing rations. The samples were frozen on dry-ice in a portable icebox at the lambing shed and then were stored in a freezer until shipped for assay.

Milk samples were taken from the same ewes from which the colostrum was obtained. These milk samples were taken from three to twelve days after the colostrum samples, with most of the milk samples being taken at eight to ten days. All samples were shipped together on dry-ice to the American Cyanamid Company, Pearl River, New York for determination of Aureomycin content.

Blood samples

Blood samples were obtained from eight ewes in both prelambing lots. The first samples were taken March 21 after the ewes were placed on the experiment. A second sample was taken April 17 after lambing had started. The samples were analyzed for phosphorus, vitamin A and hemoglobin content.

Postmortem autopsy of dead lambs

All lambs born dead or which died after birth were posted by personnel of the Montana Veterinary Research Laboratory. Dead lambs were taken into the Veterinary Laboratory as soon after death as possible and were refrigerated until the autopsy could be performed.

RESULTS AND DISCUSSION

Lamb birth weights

The ewes were weighed on the experiment March 12 and were reweighed on March 21 and April 6 before the start of lambing. The average body weights of the ewes prior to lambing are shown in Table IV.

Table IV. Average body weight of the ewes prior to the start of lambing

Ration number	1	2
Aureomycin	0	50 mg/day
Weigh date	Average weight, pounds	
March 12	146.1	146.1
March 21	152.3	152.2
April 6	152.2	149.7

The loss in weight shown by Lot 2 ewes between March 21 and April 6 cannot be explained, as both lots ate the same amount of pellets each day and were together when fed hay.

The first lamb was dropped April 11, and lambing continued through April 29. Lamb numbers were not as large as expected as the ram used in one of the breeding pens was evidently sterile since only one lamb was born in the breed line during the time of the experiment. Results of lambing are summarized in Table V.

Of the one-hundred nine ewes in Lot 1, seventy-three ewes gave birth to a lamb or lambs during the period of the experiment. This number represents 67.0 percent of the ewes. Of the ewes lambing fifty had single births, twenty-three had twins and one ewe had triplets. A total of ninety-seven lambs were born dead or alive in Lot 1, for a lambing percent

Table V. Lambing percentages, birth weights and death losses during lambing

Ration number	1	2
Aureomycin	0	50 mg/day
Ewes on experiment, number	109	109
Ewes lambing April 11-29, number	73	63
Ewes lambing of ewes on experiment,% 1/	67.0	57.8
Lambs born:		
Singles, number	50	47
Twins, number of lambs	44	30
Triplets, number of lambs	3	0
Total	97	77
Lambing percentage, 1/	89.0	70.6
Average birth weight, pounds		
Singles	10.7	10.7
Twins	9.3	9.5
Triplets	9.5	0.0
Death loss, within first week		
Singles	3	2
Twins	7	2

1/ Based on ewes lambing between April 11-29 and does not include ewes which lambed at a later date.

of 89.0.

Only sixty-three ewes in Lot 2 gave birth to lambs during the period of the experiment. This number was 57.8 percent of the ewes on the experiment. There were forty-seven single lambs and fifteen pairs of twins for a total of seventy-seven lambs and a lambing percent of 70.6.

The difference in lamb numbers between Lots 1 and 2 cannot be readily explained. These were the lambs born between April 11 and April 29 and do not include late lambs born after the ewes were returned to the purebred band. Feed and management were the same until one month before the start of lambing. The average birth date of lambs in both lots was the same, 9.3 days after the start of lambing. The lots had been equalized for age and breedline of the ewe. The distribution of ewes lambing by age and breedline is shown in Table VI.

The average birth weight of single lambs in Lot 1 was 10.7 pounds, 9.3 pounds for twin lambs and 9.5 pounds for triplets. In Lot 2, the single lambs averaged 10.7 pounds and twins 9.5 pounds.

Death losses

The death loss of single lambs within the first week after birth was three lambs in Lot 1 and two lambs in Lot 2. There was a loss of seven twin lambs from Lot 1 and two twins from Lot 2 within the first week after birth. One of the twin lambs from Lot 2 was in a control ration group at the time of death. Additional death loss after the first week amounted to five single lambs and one twin lamb while the ewes and lambs were at the Ft. Ellis farm. No further death loss occurred from the time the ewes and lambs left Ft. Ellis until the lambs were weighed on August 29. The

Table VI. Distribution of ewes lambing by age and breedline

Breedline		20		22		24		26		28		28-		
Age	Lot	1	2	1	2	1	2	1	2	1	2	1	2	Total
2	1	1		0		3		4		5		3		16
	2		4		0		2		2		4		4	16
3	1	5		0		2		3		8		4		22
	2		5		0		1		4		7		5	22
4	1	1		0		2		2		4		3		12
	2		2		0		2		2		2		1	9
5	1	2		0		1		3		4		2		12
	2		3		0		0		1		2		3	9
6	1	3		1		0		2		1		0		7
	2		2		0		0		0		0		1	3
7	1	2		0		0		1		1		0		4
	2		0		0		1		1		1		1	4
Totals		14	16	1	0	8	6	15	10	23	16	12	15	136

causes of death as determined by postmortem autopsy are shown in Table VII.

Table VII. Death loss and autopsy reports

	Lamb number	Age at death, days	Ewe ration Prelamb	Ewe ration Postlamb	Autopsy report
Singles:	6004T	22	1	2	Spinal abscess
	6400T	0	1	1/	No report
	6436T	3	1	3	Necrotic pharyngitis, laryngitis
	6844T	14	1	2	Pneumonia
	6847T	1	1	1/	Navel-ill
	6001T	12	2	3	Necrotic hepititis
	6018T	3	2	2	Starvation
	6435T	17	2	3	No report
	6612T	0	2	1/	Abortion, deformity all four fetlocks
	6840T	10	2	1	Enlarged thymus
Twins:	6024T	2	1	7	Peritonitis
	6419T	19	1	7	No report
	6817T	3	1	7	Enteritis
	6818T	4	1	7	No visible lesions
	6825T	0	1	1/	Hydronephosis
	6832T	0	1	1/	Single-ventricle heart
	6845T	7	1	7	Starvation
	6856T	2	1	7	Navel-ill
	6005T	0	2	1/	Stillborn, asphyxiation
	6837T	3	2	7	Enteritis

1/ Lamb died before ewe assigned to postlambing treatment.

There appears to be no consistent or specific cause of death loss. Starvation, enteritis and navel-ill each accounted for two deaths. The only loss due to pneumonia was in a two-week-old lamb whose mother was fed a pellet containing Aureomycin after lambing, but no Aureomycin prior to lambing. There appears to be a large difference in the death loss of twin lambs between Lot 1 and Lot 2. There was only one death loss in twins where the ewe was receiving Aureomycin at the time of death, and that was a stillborn lamb. Both cases of enteritis occurred in twins, and the ewes were not receiving Aureomycin at the time of the lambs' death.

A total of ten single lambs died during the time of the trial. The ewe was receiving an Aureomycin supplement in four of the cases, while the other six ewes were not getting Aureomycin. Of the ten twin lambs which died, the ewe was receiving an Aureomycin supplement at the time of death in only one case. In considering the causes of death as given by the autopsy report, it would be difficult to say that the difference in death losses is or is not a real one.

Aureomycin assay of colostrum and milk

Results of the assay for Aureomycin content in the colostrum and milk samples are shown in Table VIII.

Table VIII. Aureomycin assay of colostrum and milk samples

Prelambing ration Aureomycin	1 0	2 50 mg/day
Colostrum samples, number 1/	18	17
Samples showing Aureomycin, number	0	11
Avg. assay, mcg/mg of sample, 2/	0	0.050

Postlambing ration Aureomycin	1 0	2 50 mg.	3 0	4 0	5 100 mg.	6 0
Milk samples, number 1/	6	7	7	1	3	2
Samples showing Aureomycin, number	0	4	0	0	3	0
Avg. assay, mcg/ml of sample, 2/	0	0.079	0	0	0.116	0

1/ Size of samples varied from 1 1/4 to 4 ounces.
2/ Assay reports micrograms of chlortetracycline per ml. of sample. Samples with sensitivity level below 0.025 mcg/ml not recorded.

The results of the assay would indicate that there is an accumulation of Aureomycin in the colostrum and a transfer of Aureomycin into the milk while the ewe is receiving feed containing Aureomycin. Colostrum and milk from ewes receiving the control ration at the time of sampling showed no Aureomycin content. In most cases, there was approximately 10 days time between the collection of the colostrum sample and the milk sample. If the ewe was receiving Ration 2 prior to lambing and her colostrum showed an assay of Aureomycin, her milk did not show an Aureomycin content unless she continued to get Ration 2. The highest assay of Aureomycin was found in the milk of the two-year-old ewes which were receiving an average of 100 milligrams of Aureomycin per day.

Analyses of blood samples

Blood samples were analyzed for phosphorus, vitamin A and hemoglobin content. Group averages are given in Table IX for the two sampling dates.

Table IX. Phosphorus, vitamin A and hemoglobin content of blood samples

Prelambing ration	1		2	
Aureomycin	0		50 mg/day	
Sampling date	Mar.21	Apr.17	Mar. 21	Apr.17
Phosphorus, mg. per 100 ml. plasma	5.38	6.35	5.25	5.27
Vitamin A, mcg. per 100 ml. plasma	28.92	35.68	28.38	39.08
Hemoglobin, mg. per 100 ml. plasma	-	9.70	-	9.70

Phosphorus levels were within normal amounts, as given by Dukes (1955), at both sampling periods. The Aureomycin group maintained the phosphorus content during the prelambing feed period, while the control group showed a gain in blood phosphorus.

Vitamin A values were similar for the two lots at the first sampling date when the ewes had been receiving a low quality hay. These values were at a normal level for range breeding ewes, as reported by Marsh and Swingle (1955). Both groups showed an increase in vitamin A content after a month on alfalfa hay and pelleted concentrate feeds. The Aureomycin supplemented group showed a greater increase (10.70 micrograms) than did the control group (6.76 micrograms).

Hemoglobin levels were determined for the April 17 samples. Average figures for the two groups were the same, 9.7 milligrams per 100 millileters of plasma. This level is slightly below a normal content of 11 milligrams per 100 millileters of plasma given by Dukes (1955). One ewe in each lot showed about one-half the expected normal hemoglobin. The ewe showing a low level in the control group had twin lambs which she raised to weaning. The ewe in the Aureomycin group did not lamb during the time of this trial.

Weaning weights

Average lamb weights are one measure available to determine the effect of Aureomycin fed to the ewe. Lamb weights at birth and weight gains for three weigh periods are shown in Table X.

Differences in average gain between lots at the conclusion of the supplemental feeding period do not carry through to weaning in every case. The lambs were weighed on May 9 before the ewes and lambs were put out on the range. There was no statistically significant difference in weight gains between comparable groups at this date.

Table X. Average lamb weights and gains from birth to weaning

Type of birth	Singles						Twins	
Age of ewe	Mature ewes			2-yr.-old ewes			Mature ewes	
Postlamb. lot	1	2	3	4	5	6	7	8
Aureomycin	0	50mg.	0	0	100mg.	0	0	100mg.
No. of lambs	22	20	20	7	8	7	24	26
Avg. birth wt., lbs.	11.3	11.2	10.9	9.3	10.0	9.1	10.1	9.4
May 9								
Avg. wt., lbs.	25.2	24.6	23.2	22.1	22.8	20.6	19.6	19.0
Avg. gain, lbs.	13.9	13.4	12.3	12.8	12.8	11.5	9.5	9.6
July 2								
Avg. wt., lbs.	59.1	55.0	54.9	46.6	51.5	48.7	43.8	41.3
Avg. gain, lbs.	47.8*	43.8	44.0	37.3	41.5	39.6	33.7	31.9
August 29								
Avg. wt., lbs.	89.3	82.4	82.7	69.3	75.4	72.2	68.5	63.6
Avg. gain, lbs.	78.0*	71.2	71.8	60.0	65.4	63.1	58.4	54.2

* Significant at P=.05 when compared to Lot 2 or Lot 3

Single lambs from mature ewes showed gains on May 9 (average 20 days of age) of 13.9, 13.4 and 12.3 pounds for the control group, Aureomycin and delayed-fed groups, respectively. Weight gains on July 2 (74 days) were 47.8, 43.8 and 44.0 pounds for the three groups. The gains of the control group were significantly ($P < .05$) greater at this time than the gains of the Aureomycin and delayed-fed lots. This significant difference carried through to weaning (132 days) when the control group had gained 78.0 pounds, the Aureomycin and delayed-fed groups 71.2 and 71.8 pounds, respectively. Differences in gain were evidently due to a carryover effect in the Aureomycin and delayed-fed groups, as the differences were not large enough to be significant until after supplemental feeding was discontinued.

Single lambs from two-year-old ewes supplemented with an Aureomycin pellet showed greater gains than the control and delayed-fed groups at both weigh periods after supplemental feeding was discontinued. The Aureomycin group had an average gain of 12.8 pounds on May 9 when supplemental feeding stopped, which was equal to the control group gain of 12.8 pounds and greater than the delayed-fed average gain of 11.5 pounds. The Aureomycin and delayed-fed groups had gains on July 2 of 41.5 and 39.6 pounds compared to 37.3 pounds for the control group. These differences persisted until weaning when the Aureomycin, delayed-fed and control groups had gains of 65.4, 63.1 and 60.0 pounds, respectively. Differences in gain among treatments were not significant at any period.

Twin lambs showed similar gains for both the control and treated groups at the end of the supplemental feeding period, when the controls had gained 9.5 pounds and the Aureomycin lambs had gained 9.6 pounds. The controls gained 33.7 pounds to July 2 while the Aureomycin group gained 31.9 pounds. The controls gained more than the Aureomycin group to weaning, with a gain of 58.4 pounds compared to 54.2 pounds. The differences in gain between the two groups were not significant at any weigh period.

SUMMARY

A pelleted ration providing 50 milligrams of Aureomycin per day was fed to a group of ewes for a month prior to lambing. The average birth weight of lambs from these ewes did not differ from the birth weights of lambs from ewes receiving the same pelleted ration without Aureomycin. The death loss of single lambs within the first week after birth was approximately the same for both rations. The death loss of twin lambs was seven for the control ration and two for the Aureomycin supplement within the first week after birth. Total loss for the trial period was six single lambs and nine twins for the control ration and four single lambs and one twin for the Aureomycin supplemented ration.

Laboratory assay of colostrum and milk samples showed a transfer of the Aureomycin as long as the ewe was receiving Aureomycin in the feed. The highest average level of Aureomycin content was in the milk samples from two-year-old ewes receiving an average of 100 milligrams of Aureomycin per day. There was no detectable amount of Aureomycin in the colostrum or milk unless the ewe was being fed an Aureomycin supplement at the time the sample was taken.

Feeding an Aureomycin supplement to the ewe for an average of 18 to 20 days after lambing showed no benefit in lamb weaning weights. Mature ewes with single lambs which received the control ration showed significantly ($P<.01$) greater lamb gains to weaning then ewes receiving an Aureomycin supplement. Two-year-old ewes receiving the Aureomycin supplement had greater lamb gains at weaning then the control group, but the difference was not statistically significant. Gains to weaning for twin lambs were greater for the control group than the Aureomycin supplemented group, but the difference was not significant.

Two groups of ewes with single lambs were fed only hay for ten days after lambing and then were given a pelleted supplement. Lambs from mature ewes showed significantly ($P < .05$) less gain to weaning for the delayed feeding group compared to continued feeding after lambing. Lambs from two-year-old ewes showed a slightly greater but nonsignificant gain when supplemental feeding was delayed.

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Appendix Table I. Analysis of variance--weight gain of single lambs from mature ewes

Source of variation	Degrees freedom	Mean squares	F ratio	Levels 5%	Levels 1%
<u>May 9</u>					
Among treatments	2	13.70	1.06	3.15	4.98
Within treatments	59	12.97			
<u>July 2</u>					
Among treatments	2	116.49	3.82*	3.15	4.98
1 vs. 2	1	178.84	5.87*	4.00	7.08
1 vs. 3	1	165.20	5.42*	4.00	7.08
Within treatments	59	30.47			
<u>August 29</u>					
Among treatments	2	341.64	4.95*	3.15	4.98
1 vs. 2	1	587.86	8.52**	4.00	7.08
1 vs. 3	1	405.43	5.87*	4.00	7.08
Within treatments	59	69.01			

* Significant at P=.05
** Significant at P=.01

Appendix Table II. Analysis of variance-- weight gain of single lambs from two-year-old ewes.

Source of variation	Degrees freedom	Mean squares	F ratio	Levels 5%	Levels 1%
May 9					
Among treatments	2	3.73	0.213	3.52	5.93
Within treatments	19	17.53			
July 2					
Among treatments	2	33.10	0.659	3.52	5.93
Within treatments	19	50.24			
August 29					
Among treatments	2	53.86	0.696	3.52	5.93
Within treatments	19	77.33			

Appendix Table III. Analysis of variance--weight gain of twin lambs from mature ewes.

Source of variation	Degrees freedom	Mean squares	F ratio	Levels 5%	Levels 1%
May 9					
Among treatments	1	0.04	0.01	4.04	7.19
Within treatments	48	7.76			
July 2					
Among treatments	1	45.33	1.06	4.04	7.19
Within treatments	48	42.96			
August 29					
Among treatments	1	206.65	1.50	4.04	7.19
Within treatments	48	137.35			